Electroformed Integral Shells for the Con-X HXT

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The Three Major Goals for HXT

- Angular resolution of 15 arcsec
- Staying within mass limit of 750 kg (optics + detector)
- Obtaining sufficient effective area (1500 cm**2 at 40 keV)

I. Review Advantages of Electroformed Replicated Shells

II. Review Progress of Electroformed Shells

III. Redesign Options ….50 m f.l.

IV. Future Work/Improvements

I. Advantages compared to segmented mirrors

- **Expect better angular resolution from stiff closed shells** as shown by experience: JET-X/SWIFT 17" HPD, XMM-Newton 15" HPD and recent measurement of thin replica from JET-X (SWIFT) mandrel

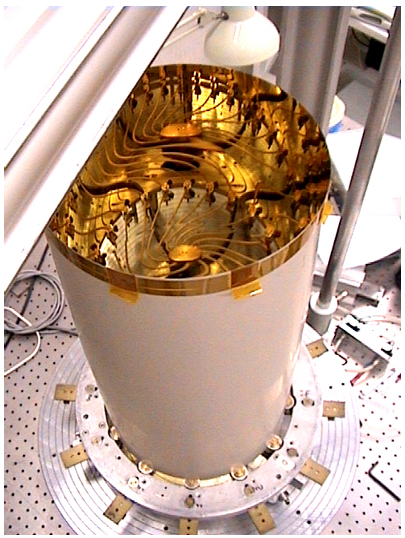
- **Replication well adapted to making 12 or more identical copies**

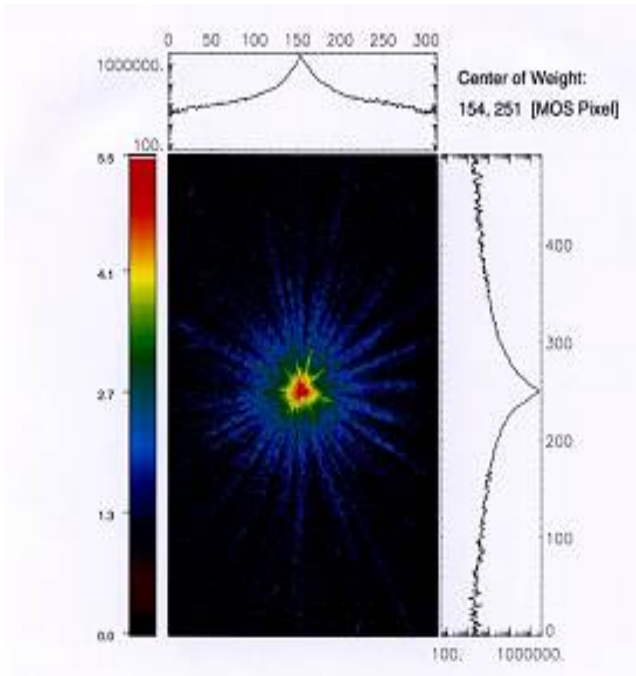
- **Fewer parts, simpler integration of reflectors into a telescope**, 90 to 112 shells per telescope, total of 1000 to 1340 shells for all four Con-X S/C

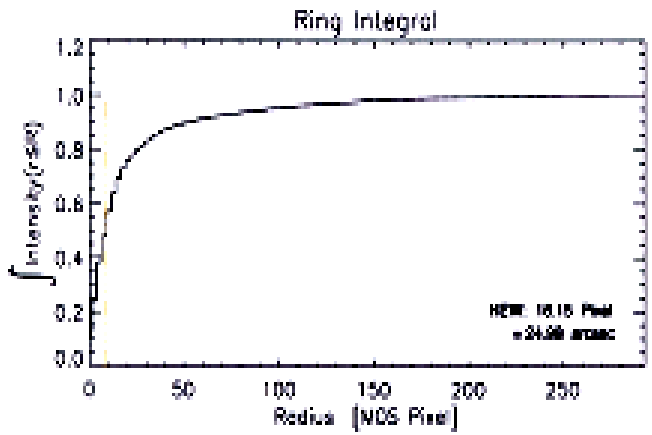
II. Review Progress: Electroformed shells

Replicating Light Weight Mirrors

- From existing SWIFT mandrel, fabricated light weight mirror shell
- Total weight of new, thinner, integral shell mirror system satisfies Con-X HXT mass limit.
- X-ray tests of thin shell at MPE Panter facility(1.5 keV) showed 25 arcsec resolution, half power diameter (30cm diam., 130 mic. wall)





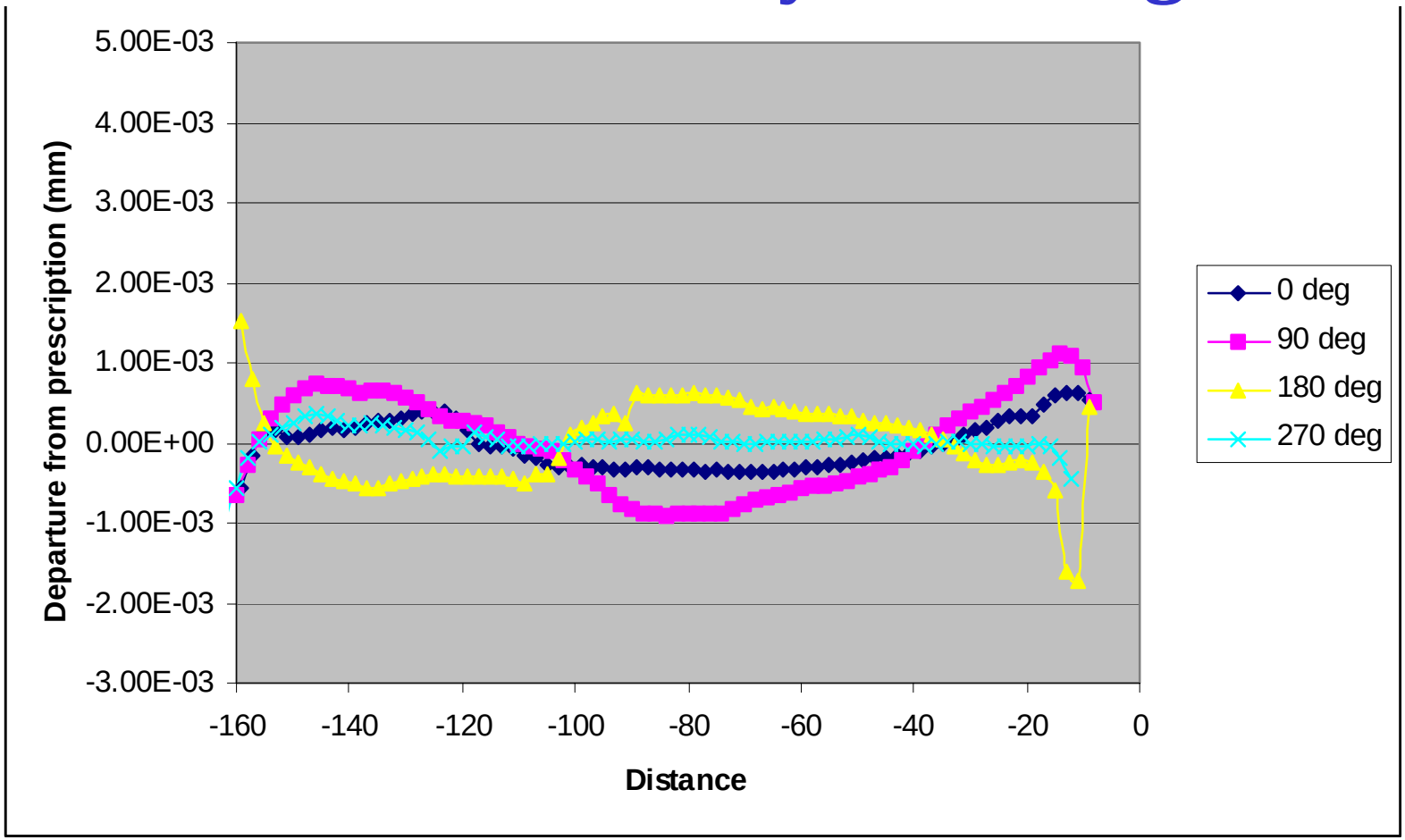


Effect of Stress in Multilayer Coating on shell figure

MSFC fabricated four 23cm diameter 100 micron thick Ni shells (from test mandrel) for Stress tests

Metrology measurements
along several azimuths
Before and after coating
Show no trends toward
Bowing of the optic
which would be expected
If distortion of the optic
Were introduced due to stress
In the coating process

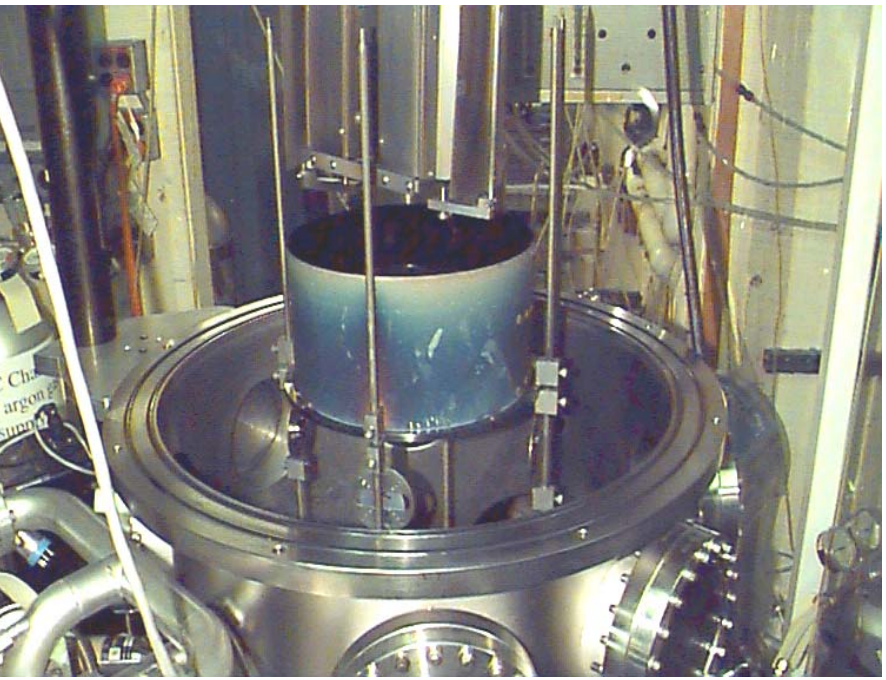
Cone 10, measurements before minus after multilayer coating

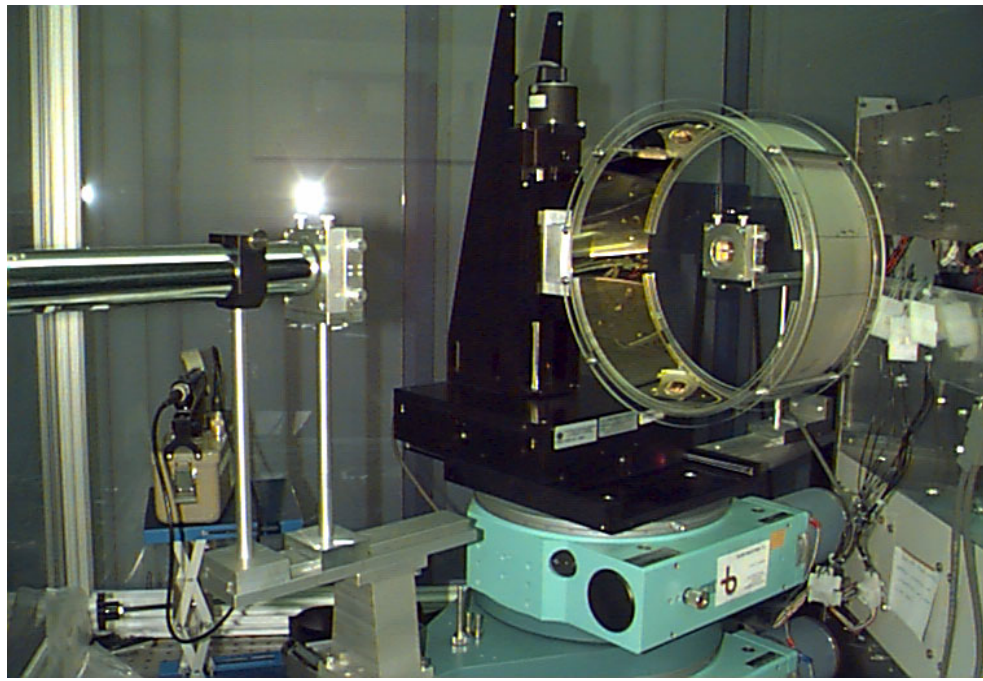


Effect of coating is changes of a micron over 10 cm, or slopes of less than an arcsecond.

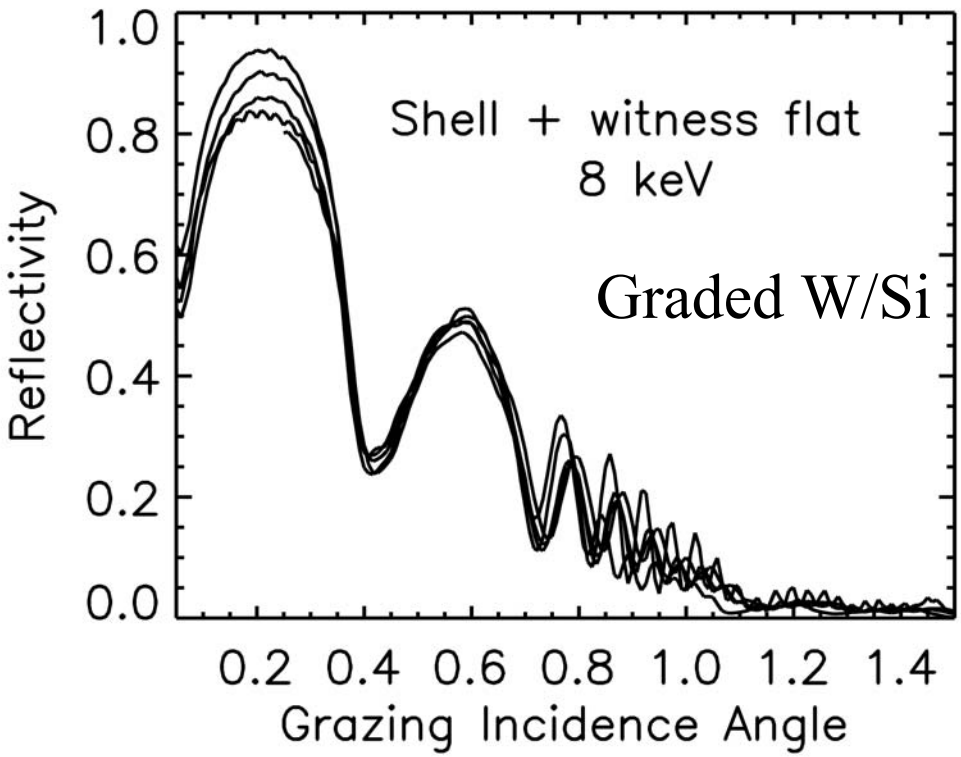
Accomplishments over last year
Coating of Test shells

- Coat several replica shells with multilayers
- Tested coated shells by measuring 8 keV reflectivity

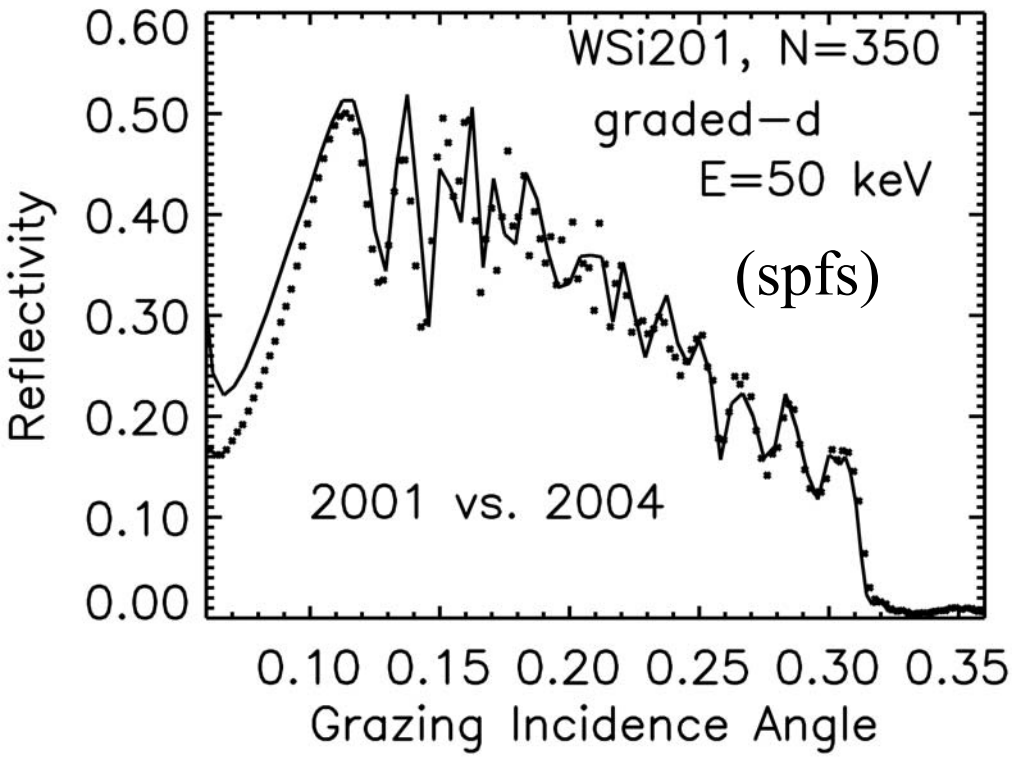




8 keV Measurements (uniformity)

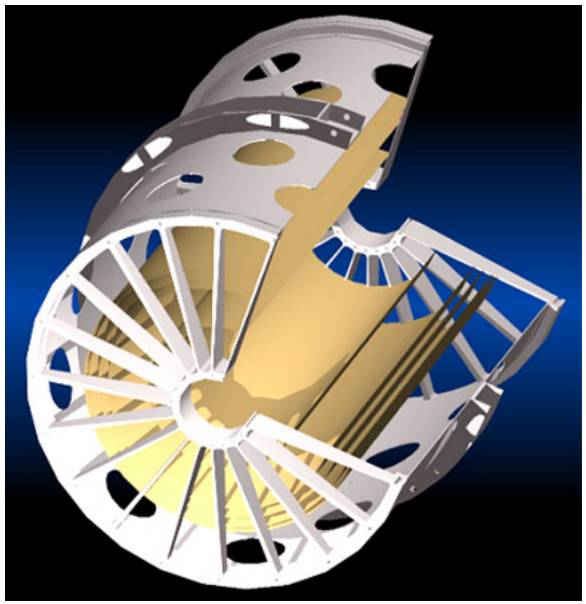


Long Term Stability
(BNL/NSLS)



SAO/OAB/MSFC Integral Shell Prototype For X-ray Testing

Focal Length = 10000 mm
Mirror length = 426 mm



- ✓ **3 shells (∅ = 250, 270, 280 mm) provided by OAB;**
- ✓ **deposition of the multilayer films at CfA;**
- ✓ **2 additional shells (∅ = 240 and 150 mm) provided by MSFC. The 150 mm shell will be coated with single layer, Ir;**
- ✓ **integration at OAB;**
- ✓ **full-illumination tests at the 102 m Hard X-ray facility of NASA/MSFC.**

X-ray tests to be re-scheduled to FY 05-06

Activities, Current (mandrel)Status

OAB is contributing 3 shells to the prototype, 25, 27, 28 cm diam. All 3 mandrels have been machined and ground to rough finish

1st mandrel has been superpolished. Expect 1st shell to be delivered Nov. 2004

23-cm and 15-cm mandrels completed at MSFC- ready to fabricate shells

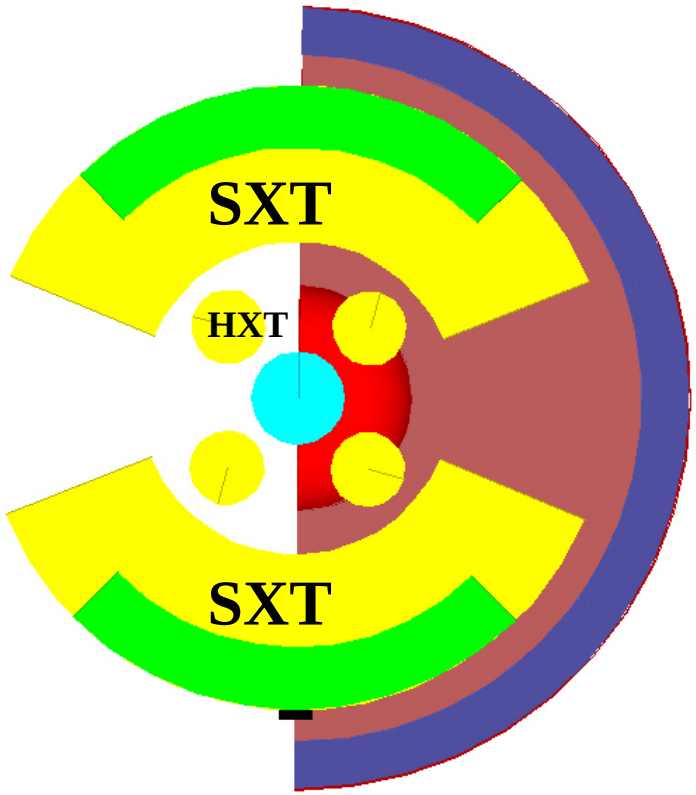
III. Redesign Options .. 50 m

- Possible Configurations for HXT modules

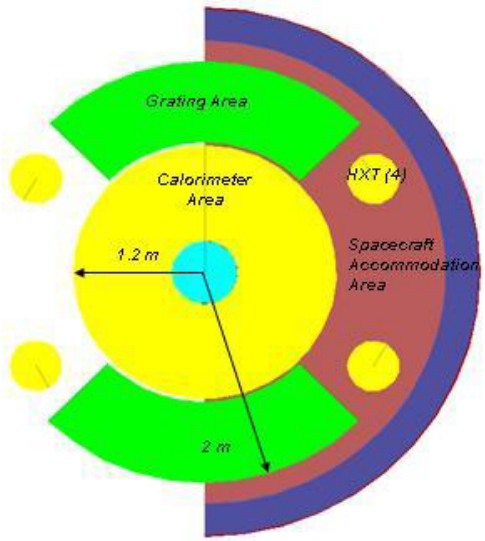
- Obtaining sufficient effective area

Possible 50 m Configuration HXT

Option 1: Telescopes in central region (2,3,4)



Option 2: Telescopes 'outboard' (2 or 4)

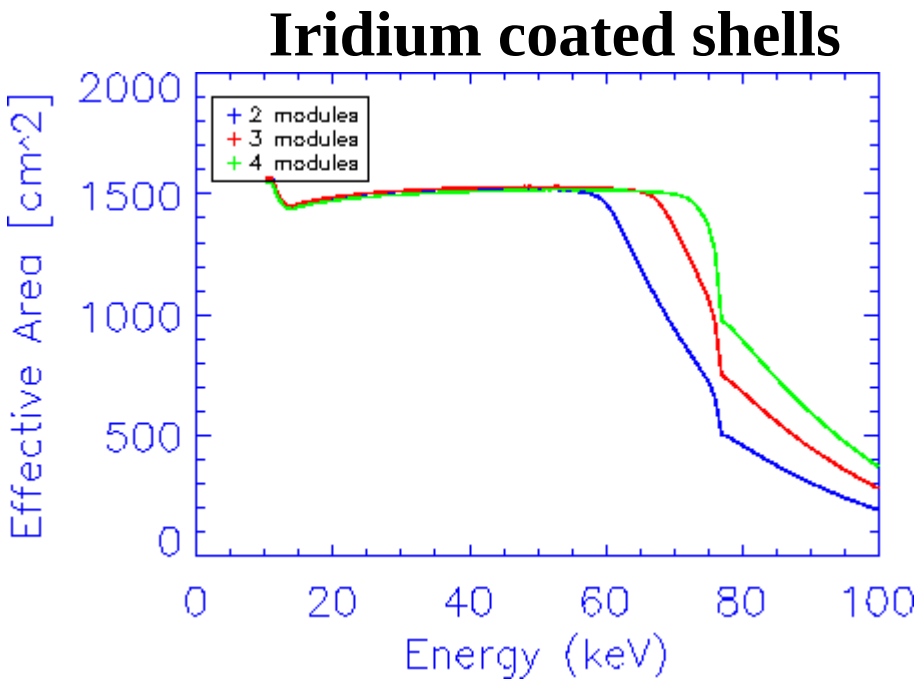


Model Parameters ?

- ✓Focal Length
- ✓Effective Area
- Shell length
- Space between shells
- Coating
- Minimum diameter
- Maximum diameter

Effecive Area = 1500 cm**2 (40 keV)

(retain ‘old’ specification)

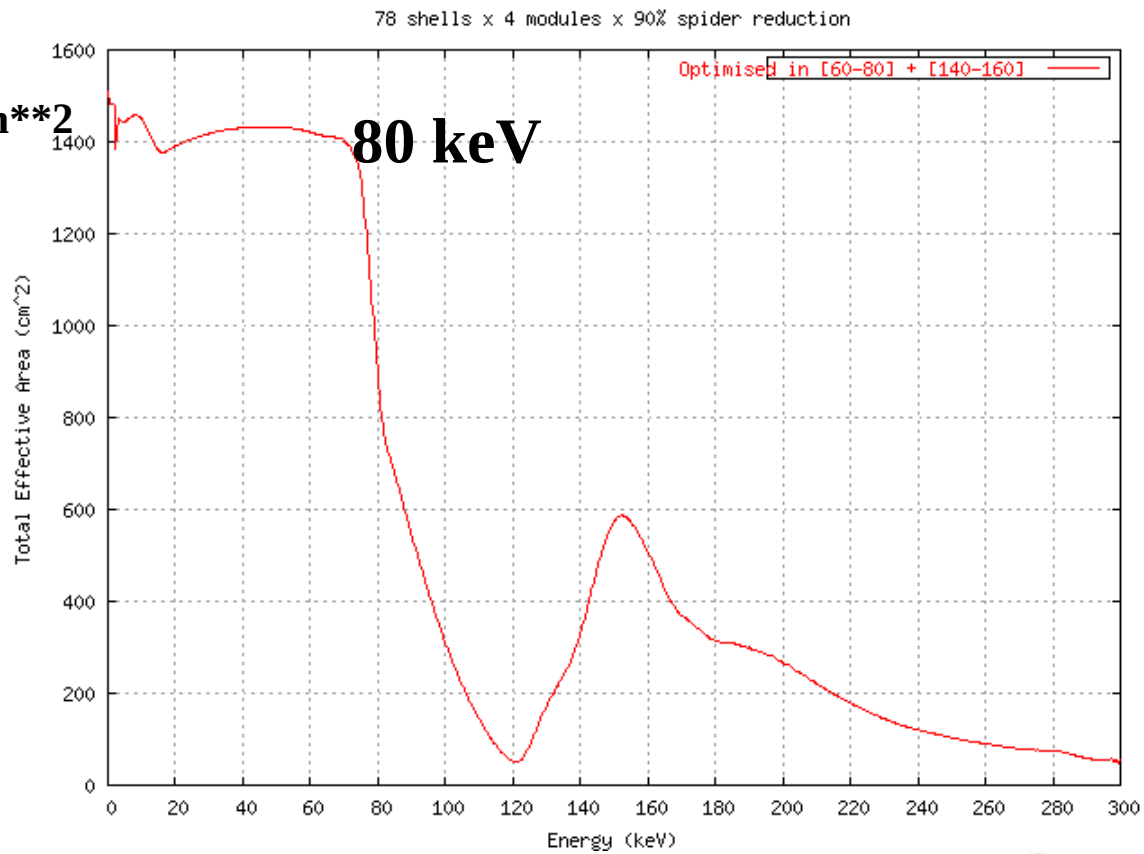


2: 127 shells/mod, rmax=27.2cm

3: 100 shells/mod, rmax=24cm

4: 83 shells/mod, rmax=22cm

4 module option
Pt/C multilayers applied



1500 cm2**

80 keV

IV. Future Work/Improvements
Development of High Strength Alloys

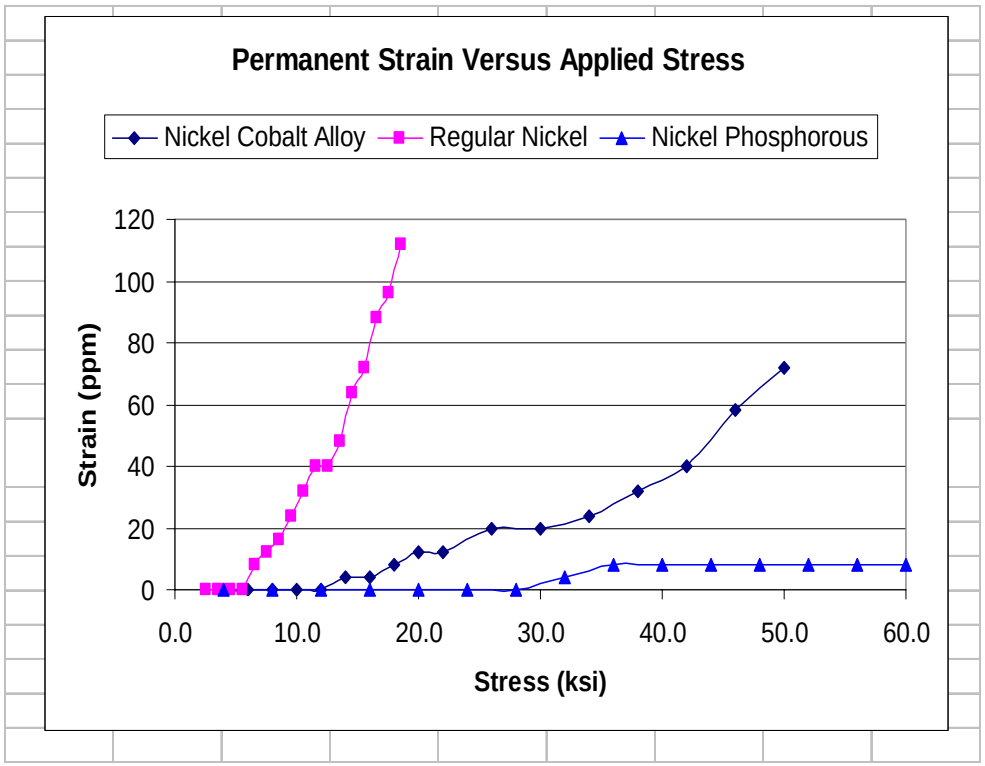
Very-thin shells can experience large strain stresses under separation from a mandrel

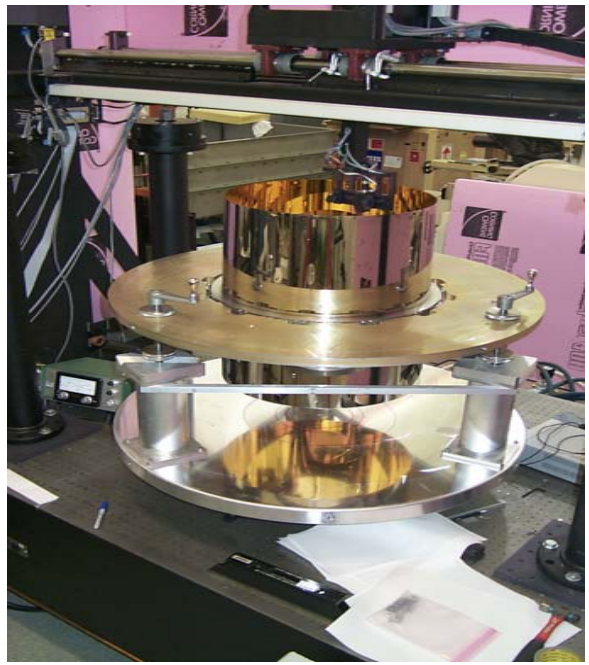
Small stresses can cause microyielding → degrade resolution

Now developing alloys with higher microyield strengths than pure nickel → stronger, lighter weight, larger diameter,higher resolution

Work on electrocomposites for ENR ongoing

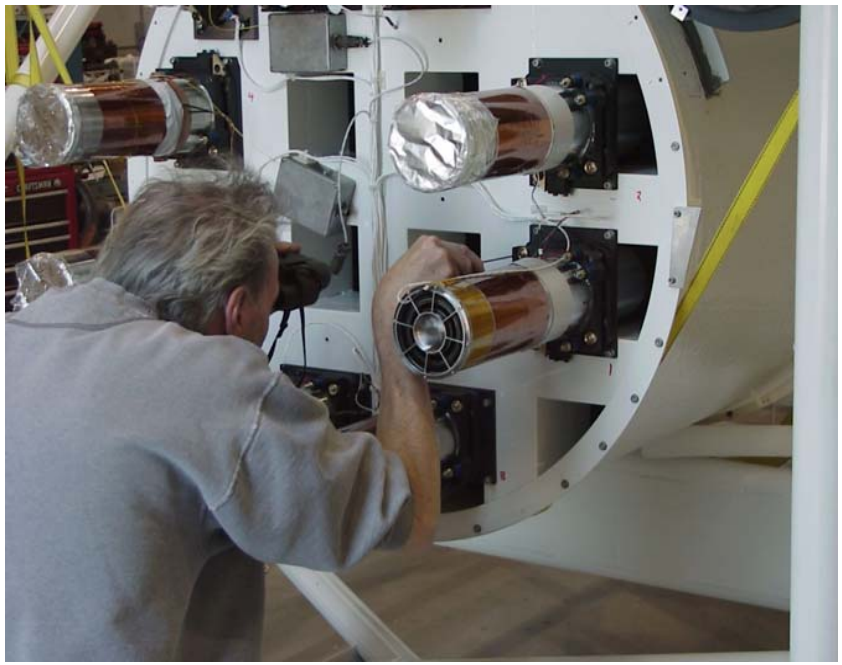
ENR Development





A 0.5-m-diam, 0.15-mm-thick Nickel-Phosphorous shell

Hard-X-Ray ENR Optics



HERO Balloon Payload

Hard-x-ray optics

8 modules, each with 8 nested nickel alloy shells, 0.25 mm thick

***13-14 arcsec HPD shells, 18 arcsec modules*

***Fabricated on modest budget*

Awaiting flight in New Mexico

Current/Proposed Activities

- Redesign/optimize for proposed 50 m configuration
- ****Need Updated Specifications to Optimize**
- Construction of the prototype (2004 funding due soon)
- Xray testing (MSFC, MPE-Panter)
- Study of effect of stress in multilayer coatings upon figure (Pt/C)
- Long term stability Pt/C

»THE END